Application of Thermal Scanner Imagery to Watershed Hydrology

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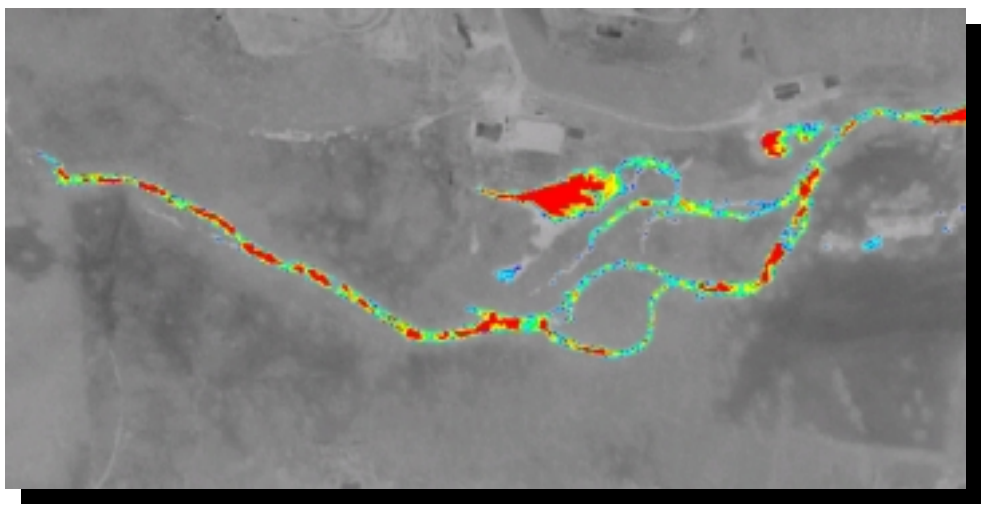
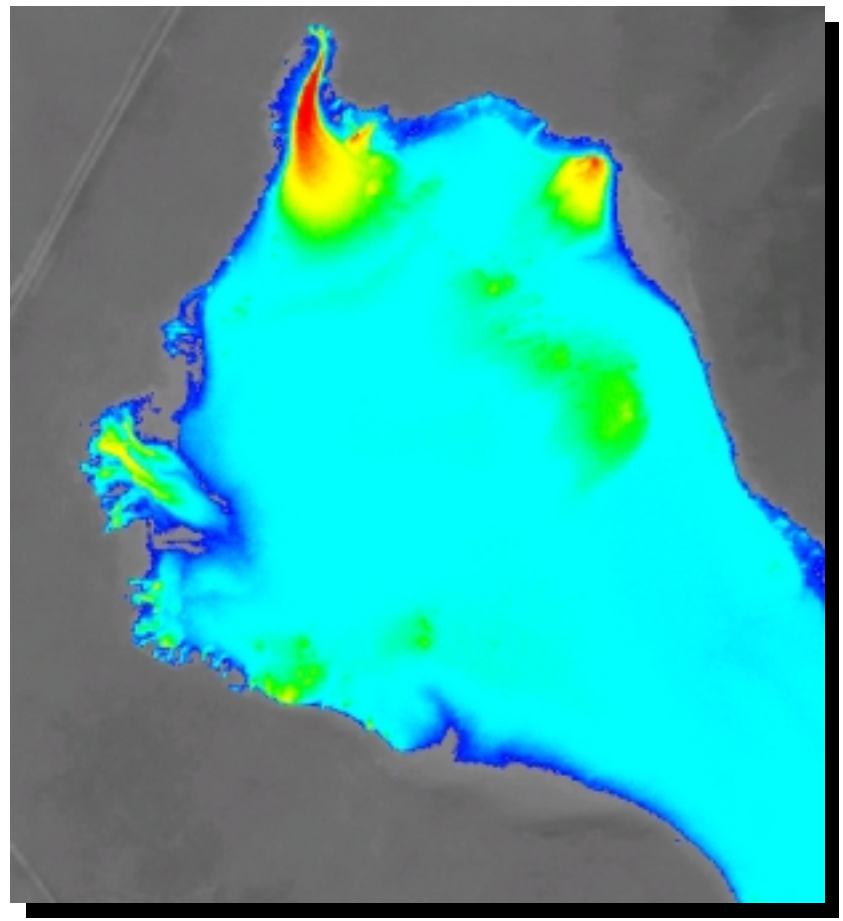


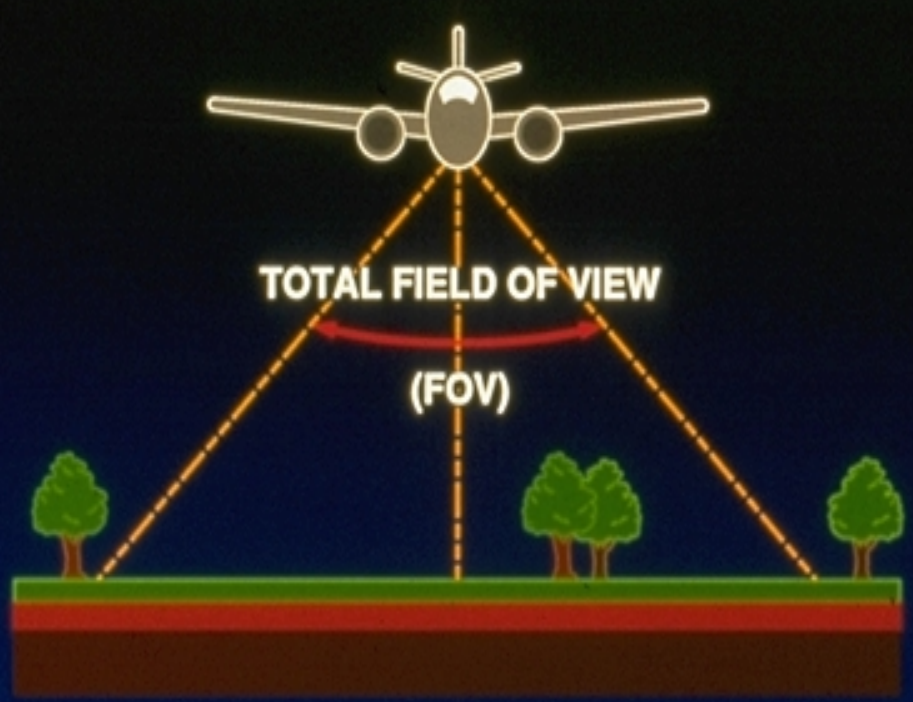


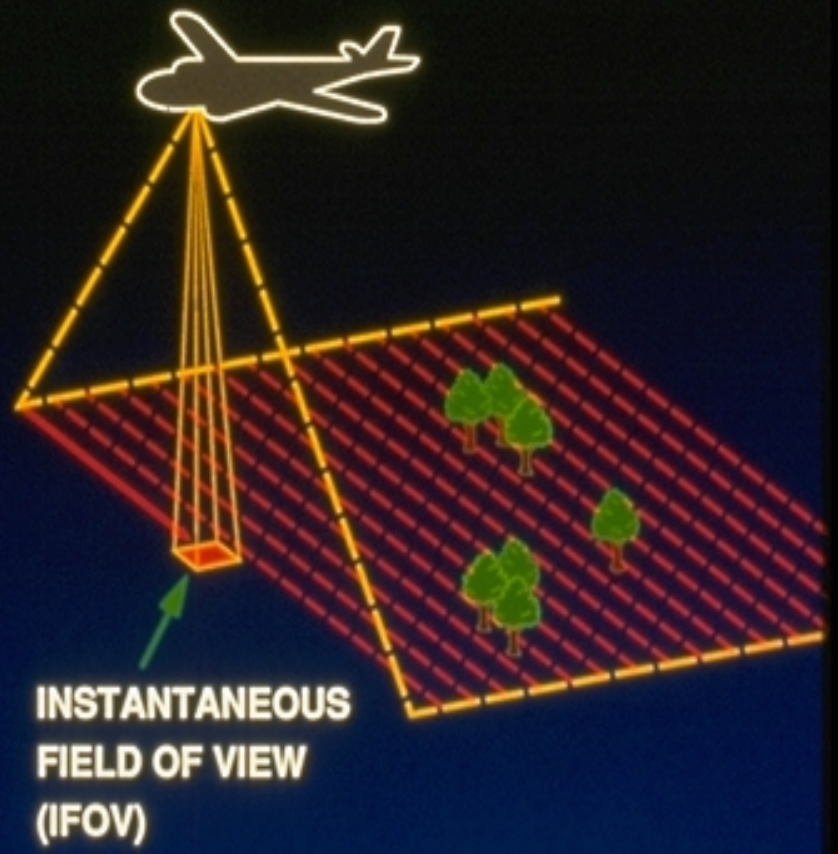
Airborne Multispectral Scanner

Airborne Vehicle

SenSyTech utilizes a select group of aerial survey companies for its airborne platform. Our sensors install easily into most aerial survey type aircraft.

Scanning Geometry





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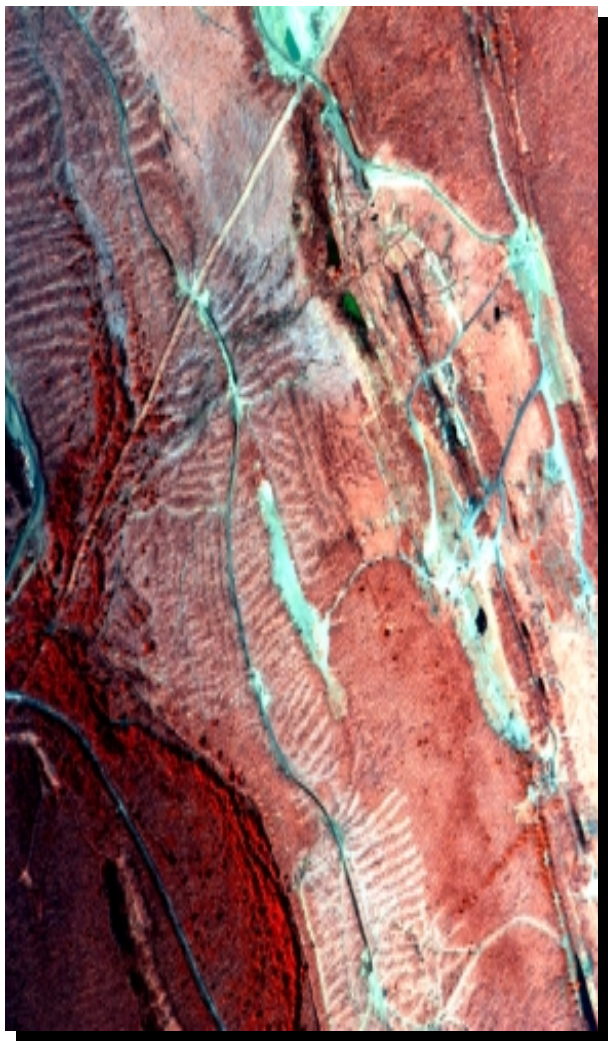
Multispectral Data Collection

Color Infrared



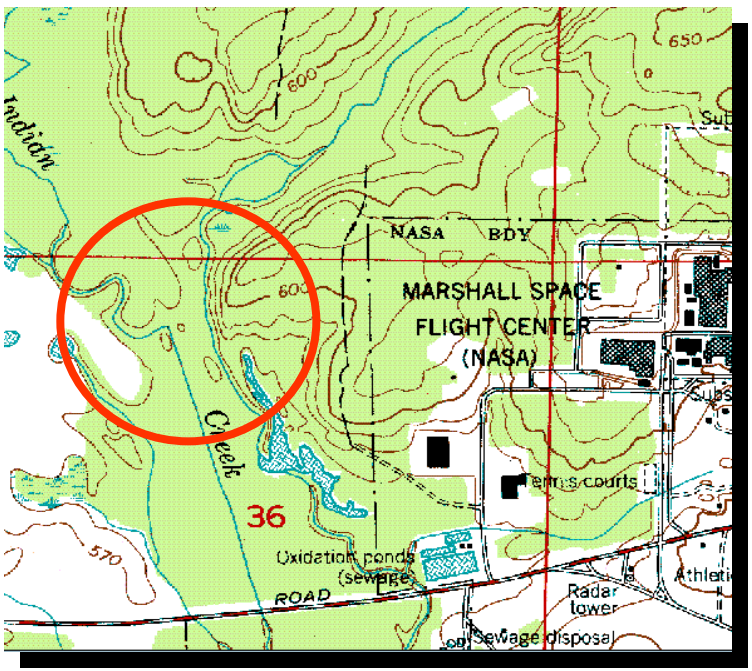
Thermal Infrared

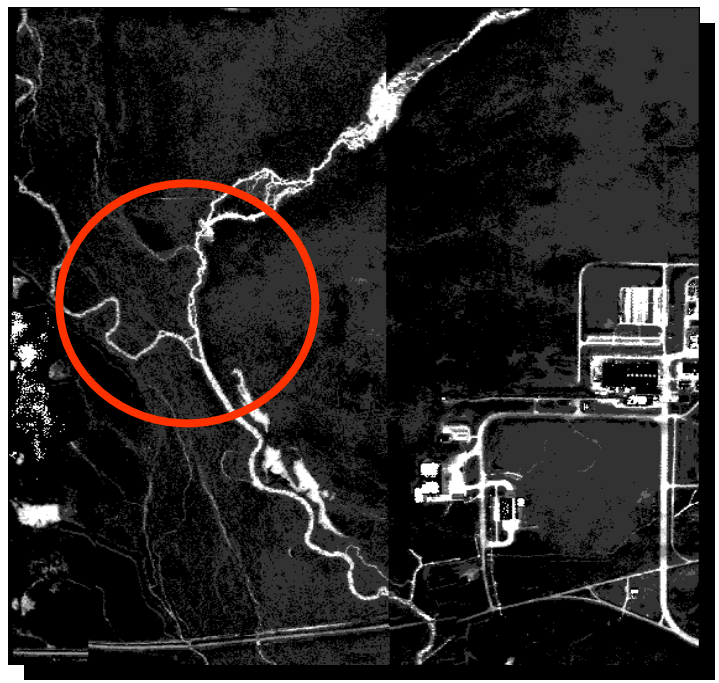
Natural Color

REASONS FOR LOCATING SPRINGS AND SEEPS

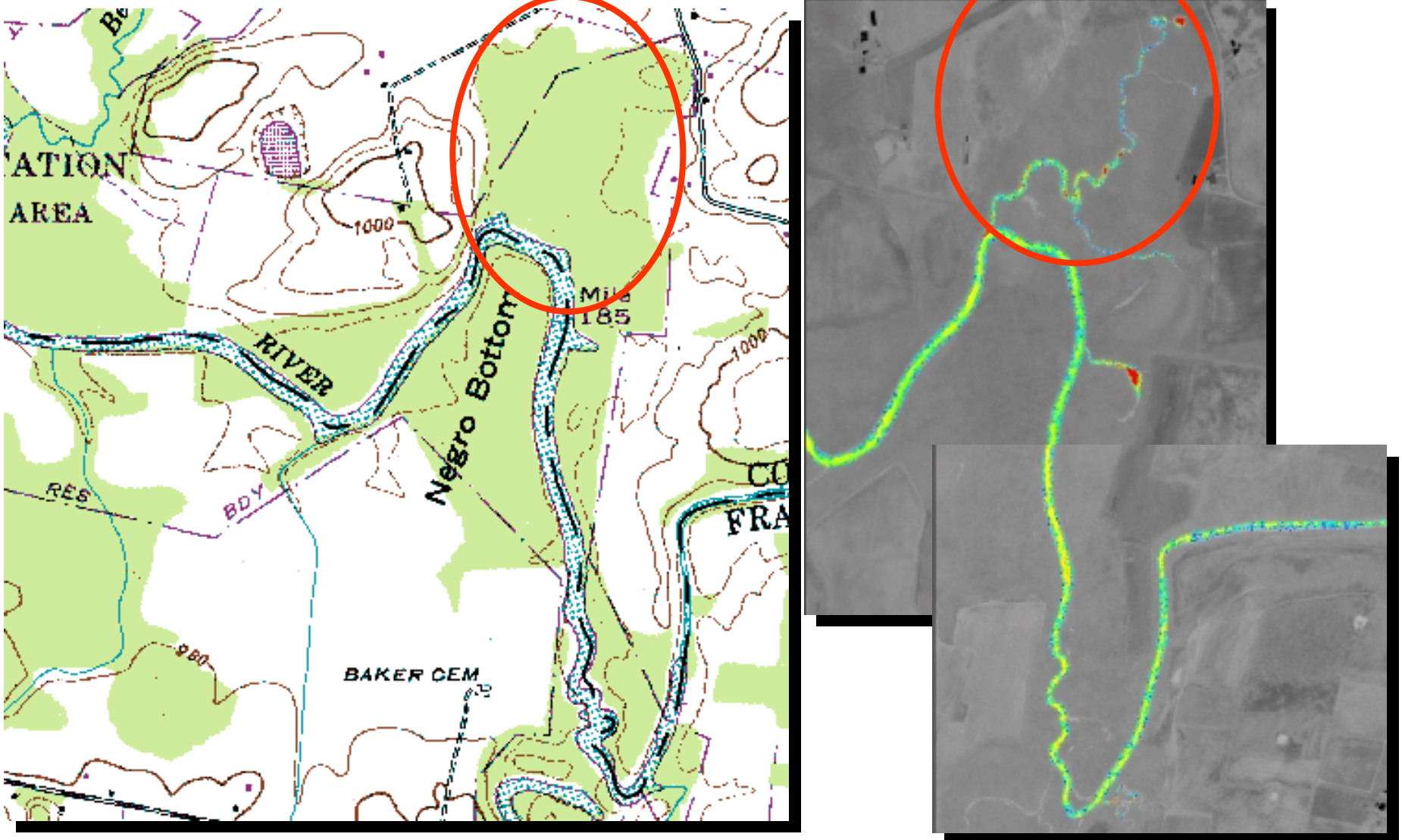
- Acid Mine Drainage
- Unique aquatic ecosystems
- Drinking water supplies
- Aid for dye tracing in karst or mining areas
- Fisheries
- Spring aquaculture
- Determine contaminant transport parameters of surface streams

APPLICATION OF THERMOGRAPHY TO HYDROGRAPHIC SURVEYING





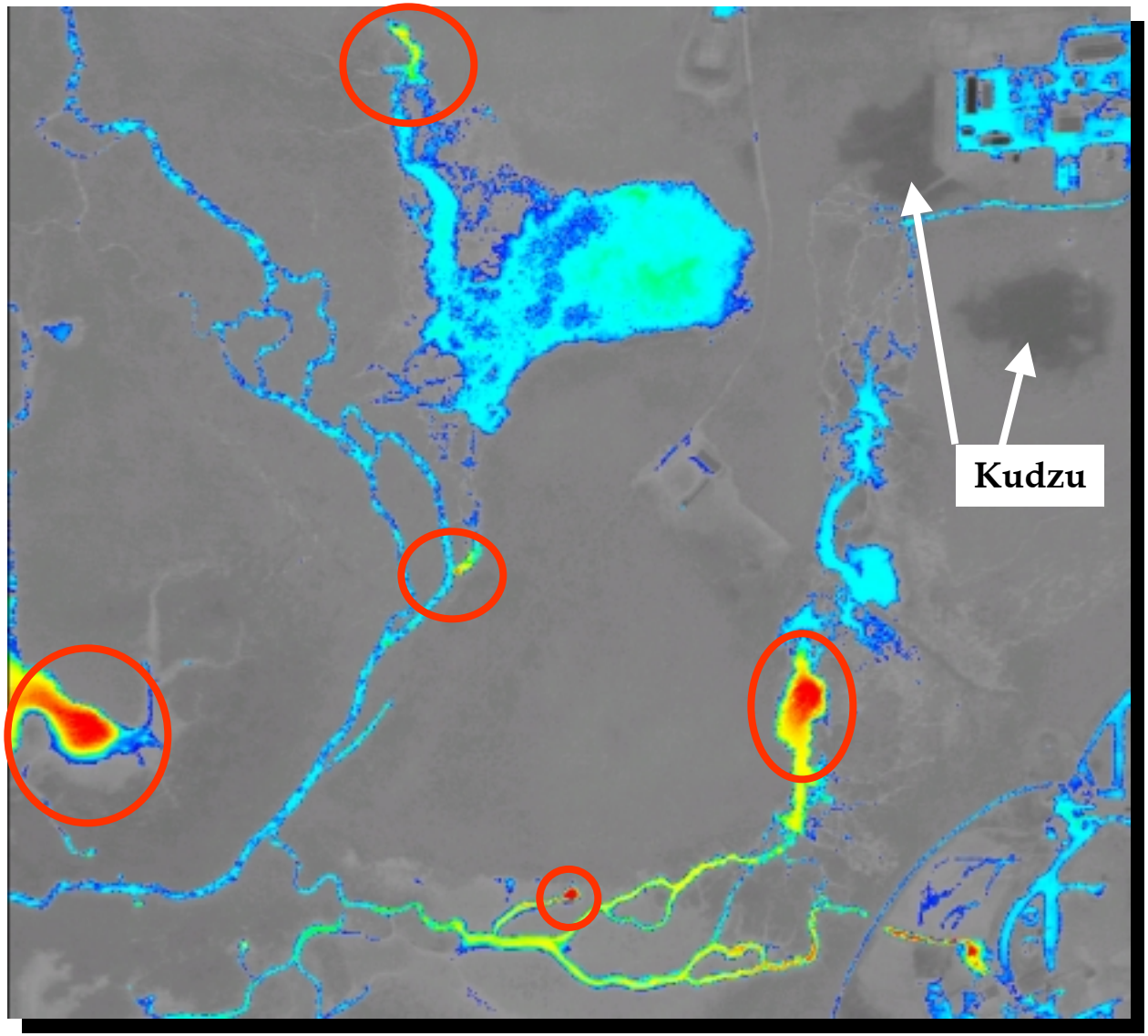
LARGE SPRING BRANCH (20 CFS) MISSED ON TOPO MAPS



DESIRED CONDITIONS FOR THERMOGRAPHY FLIGHT

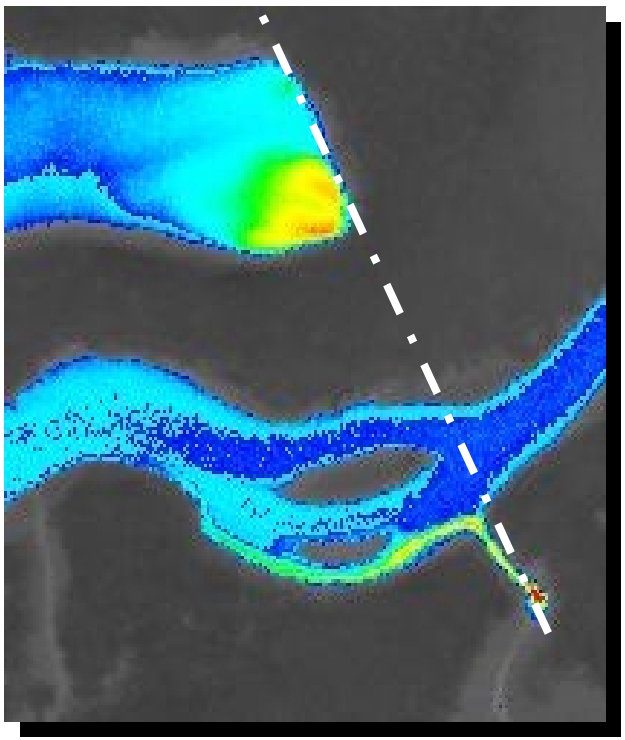
- Desired conditions
  - Greatest temperature contrast between groundwater and surface temperatures
  - Leaf-off conditions
  - Early flight so spring location takes place during leaf-off conditions
  - Groundwater at desired levels
  - Lake temperatures contrast with groundwater temperatures
  - Lakes uniformly stratified (no thermocline) and cold (~ +4°C)
- Other considerations
  - Groundwater temperatures ~ mean annual surface air temperature
  - Instrument sensitivity = 0.1°C
  - Pixel size ~ 1 m
  - Can find springs with thermography that are smaller than 1 m across
  - Would prefer contract in place in fall so that planning and early flight is possible
  - An early flight permits more springs to be located during leaf-off conditions
  - Flight-to-field time ~ 1 month

SOME SPRINGS INCORPORATED INTO GROUNDWATER MONITORING PROGRAM



SPRINGS WITH THE SAME WATER SOURCE ON OPPOSITE SIDES OF SURFACE STREAM

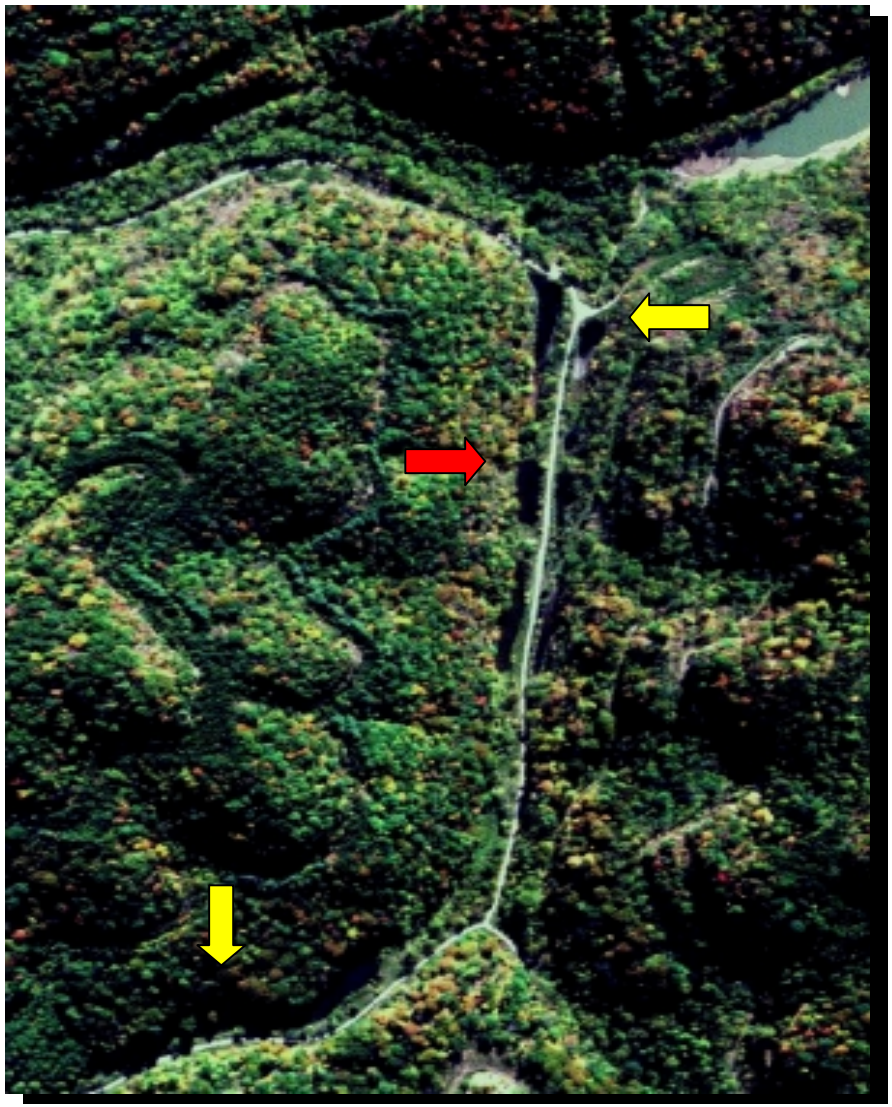
Springs Lining Up Along Photolineament



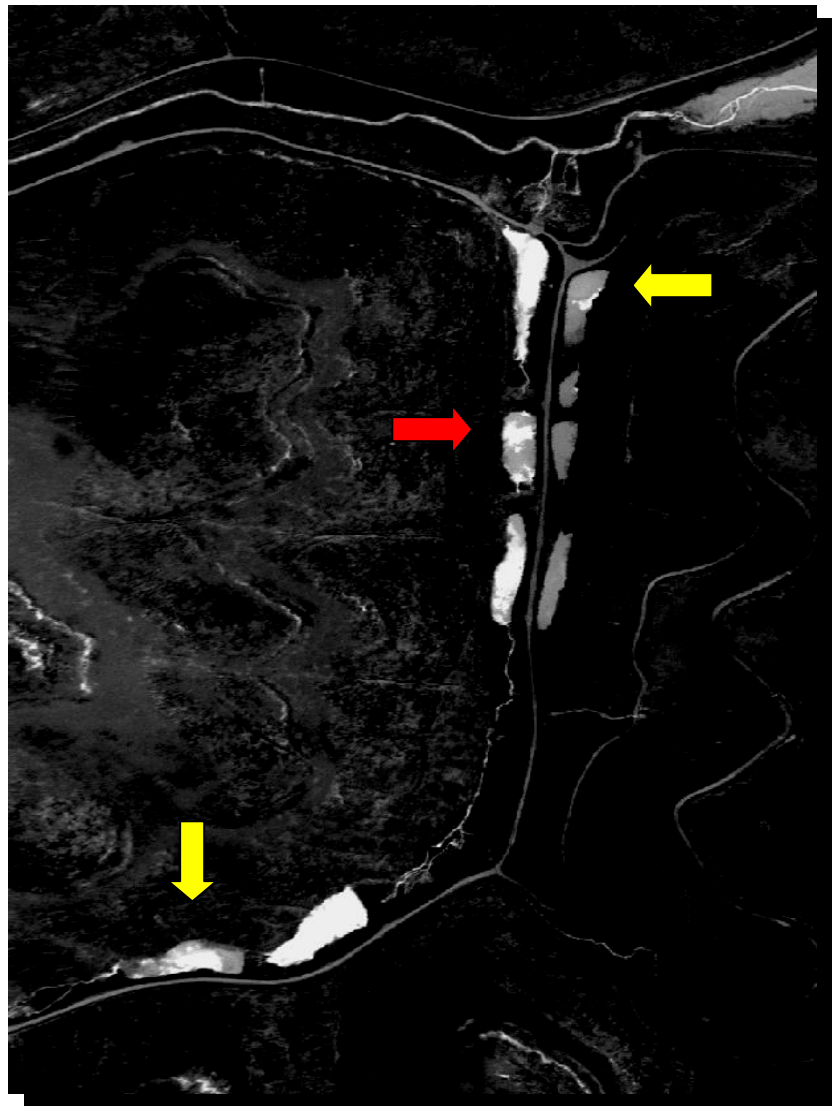
Not Every Blue Hole Discharges

Acid Mine Drainage (AMD) Seep Detection

Natural Color



Nighttime Thermal Infrared



Ground Truthing Element

SenSyTech, Inc. does not perform any ground truthing. However, we have several relationships in place with engineering firms and have work with those firms to refine the ground truthing element. Jaya Corp. has taken the TIR data, analyzed for anomalies, performed the field surveys and incorporated the data into the customers GIS.

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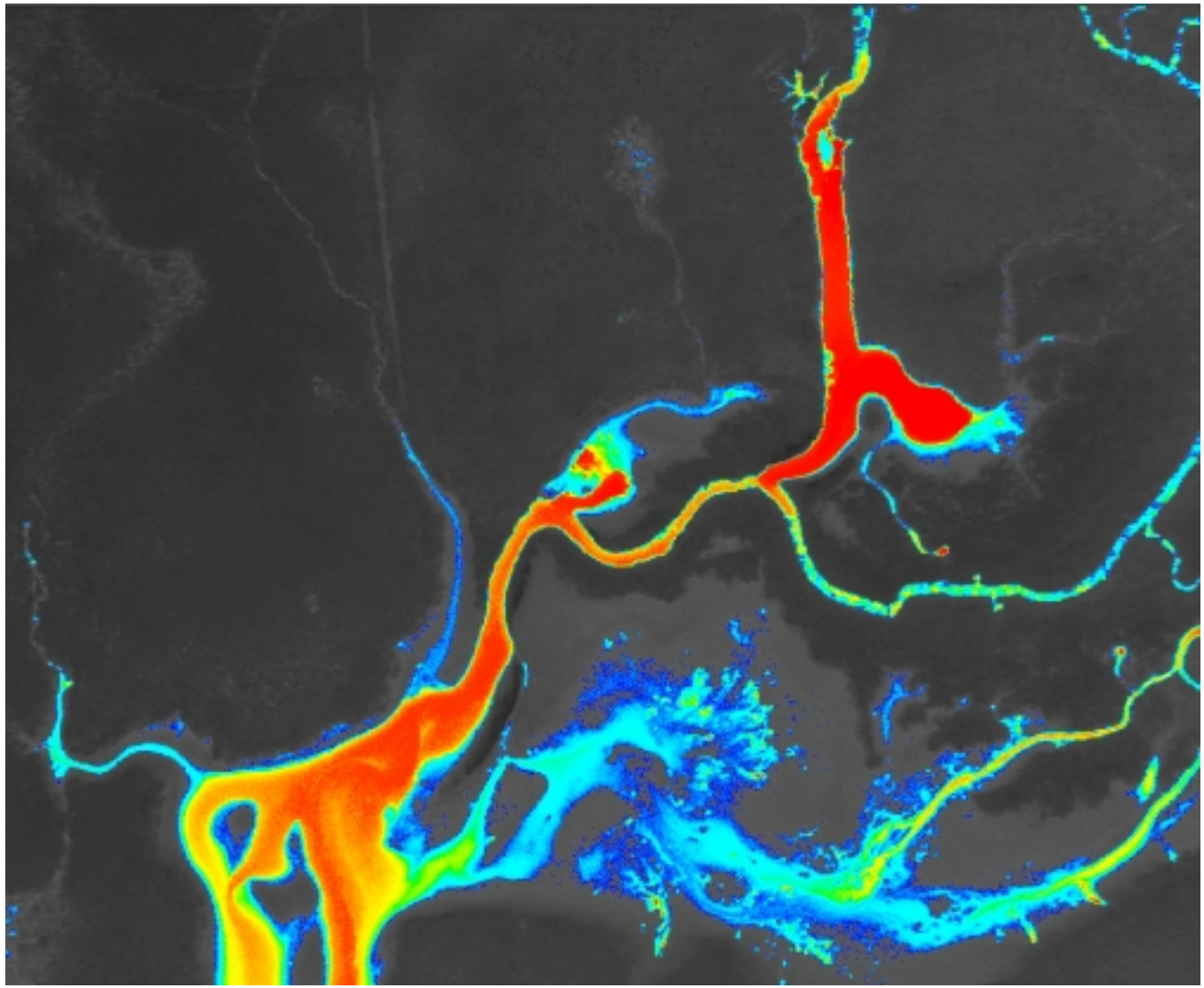
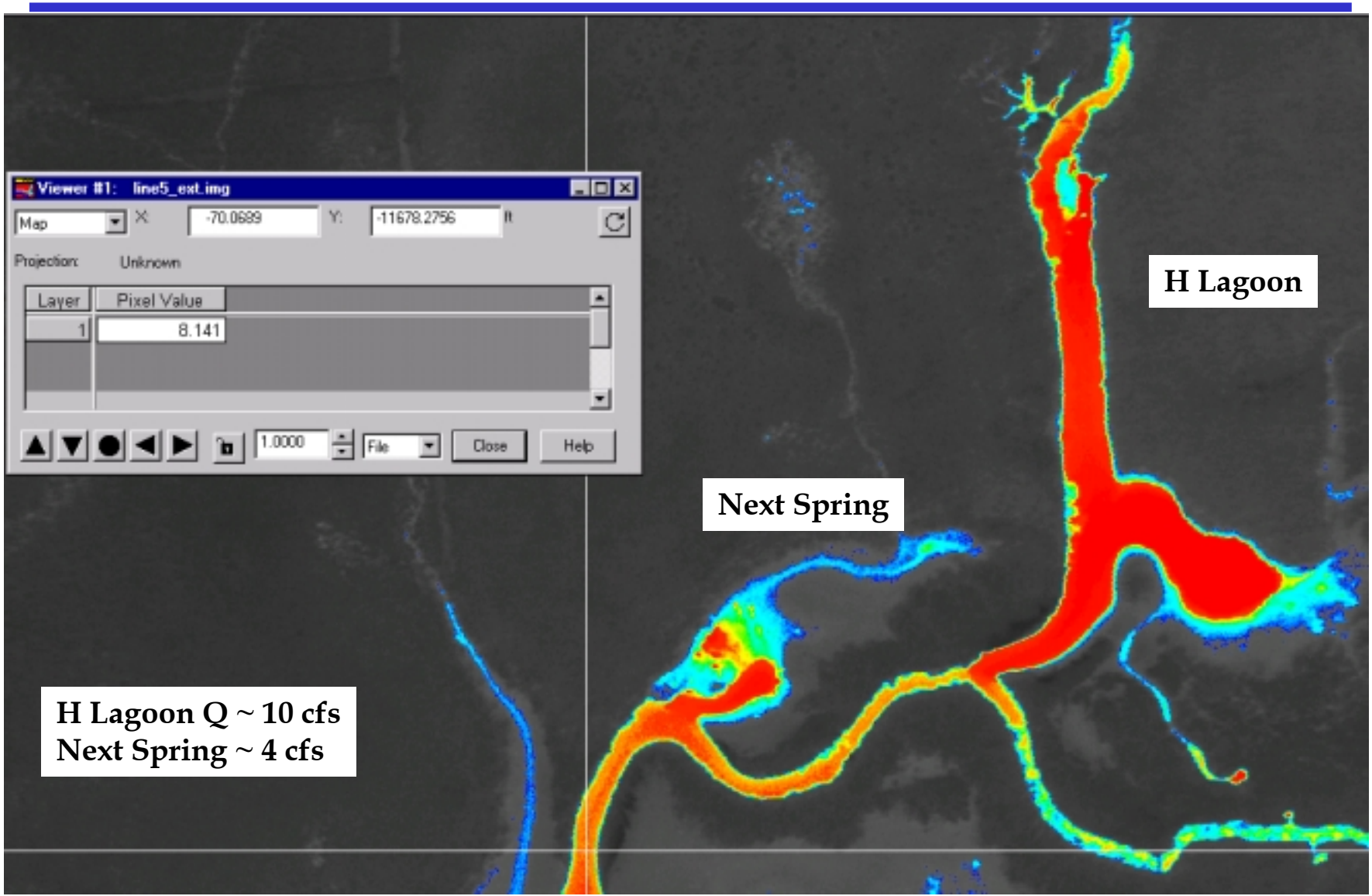
GROUNDWATER MIXING WITH SURFACE WATER



Measuring Temperature of Upwelling



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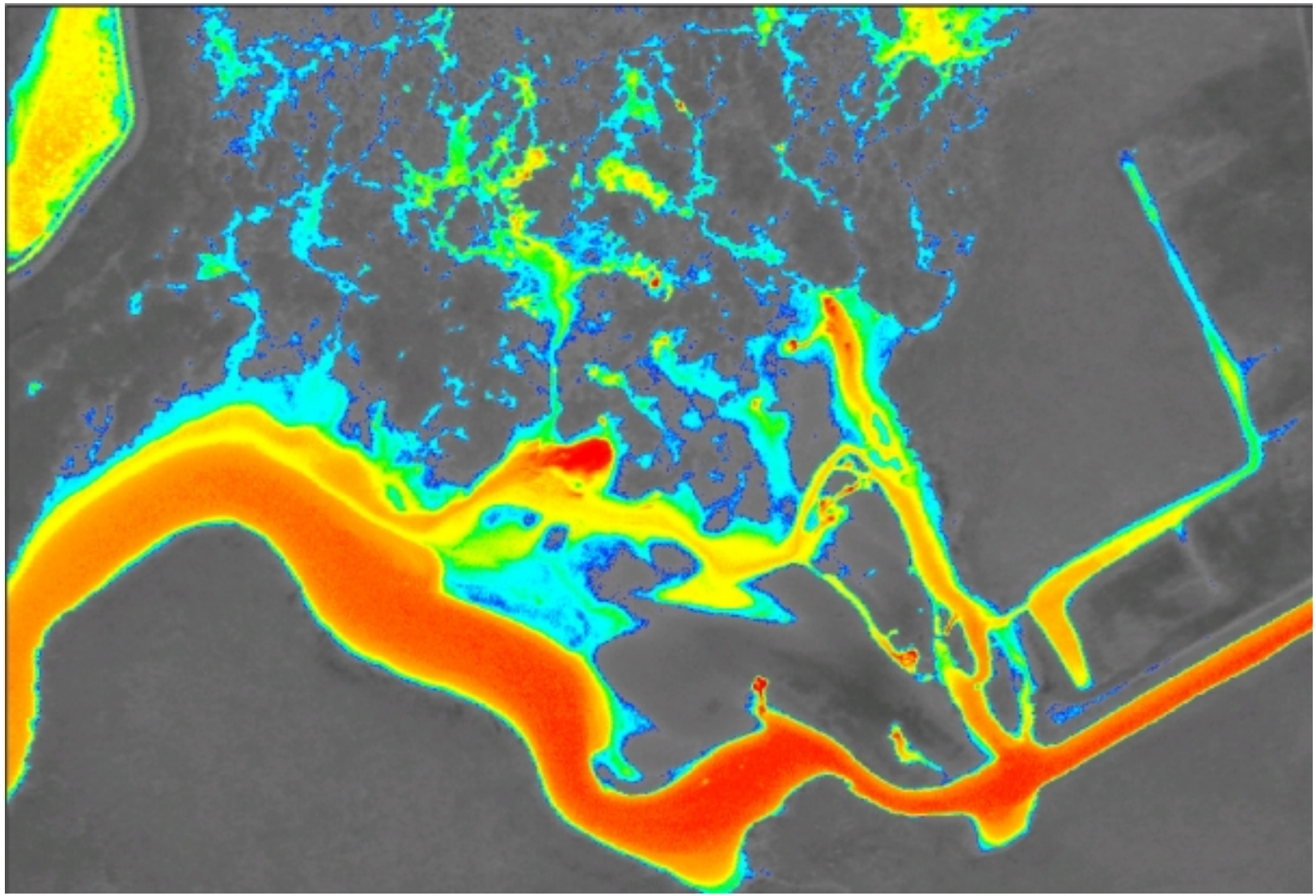
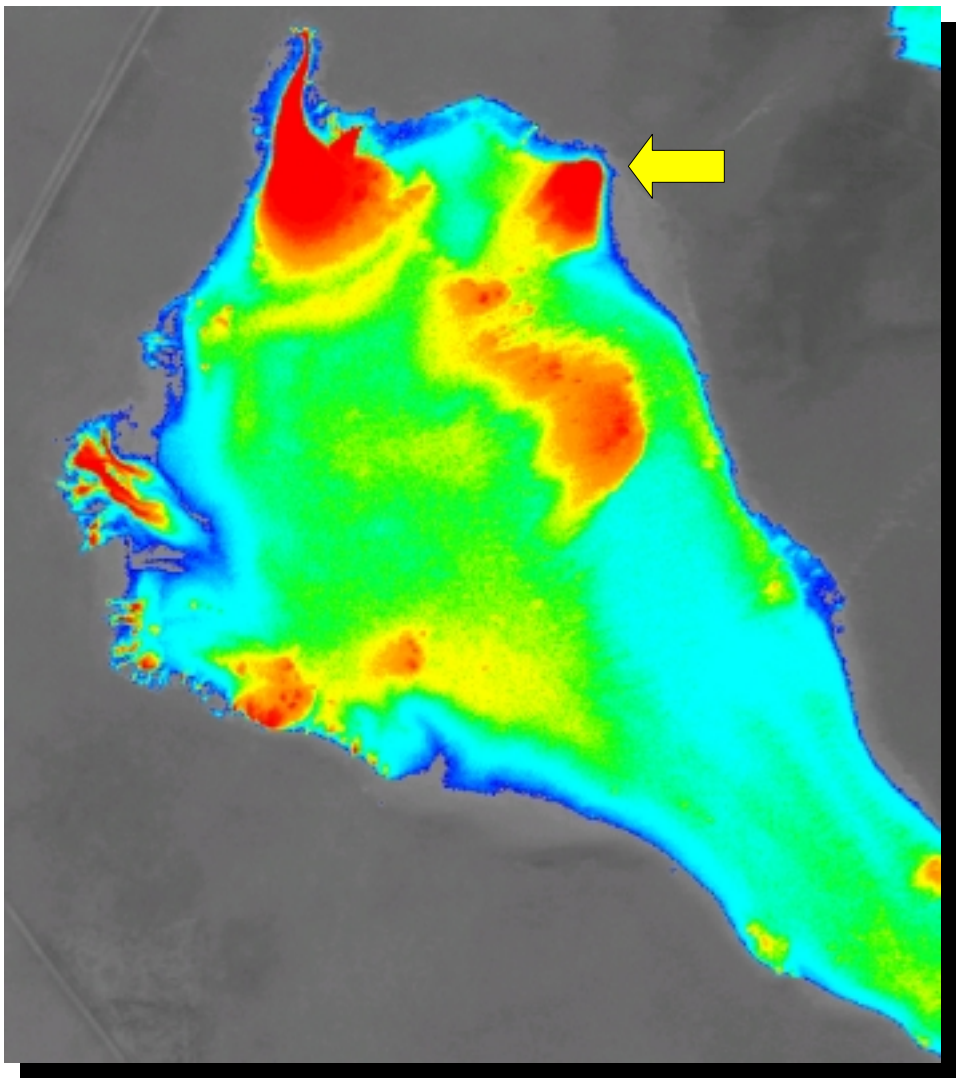
THERMOGRAPHY CAN DETECT MORE THAN CAN BE FOUND



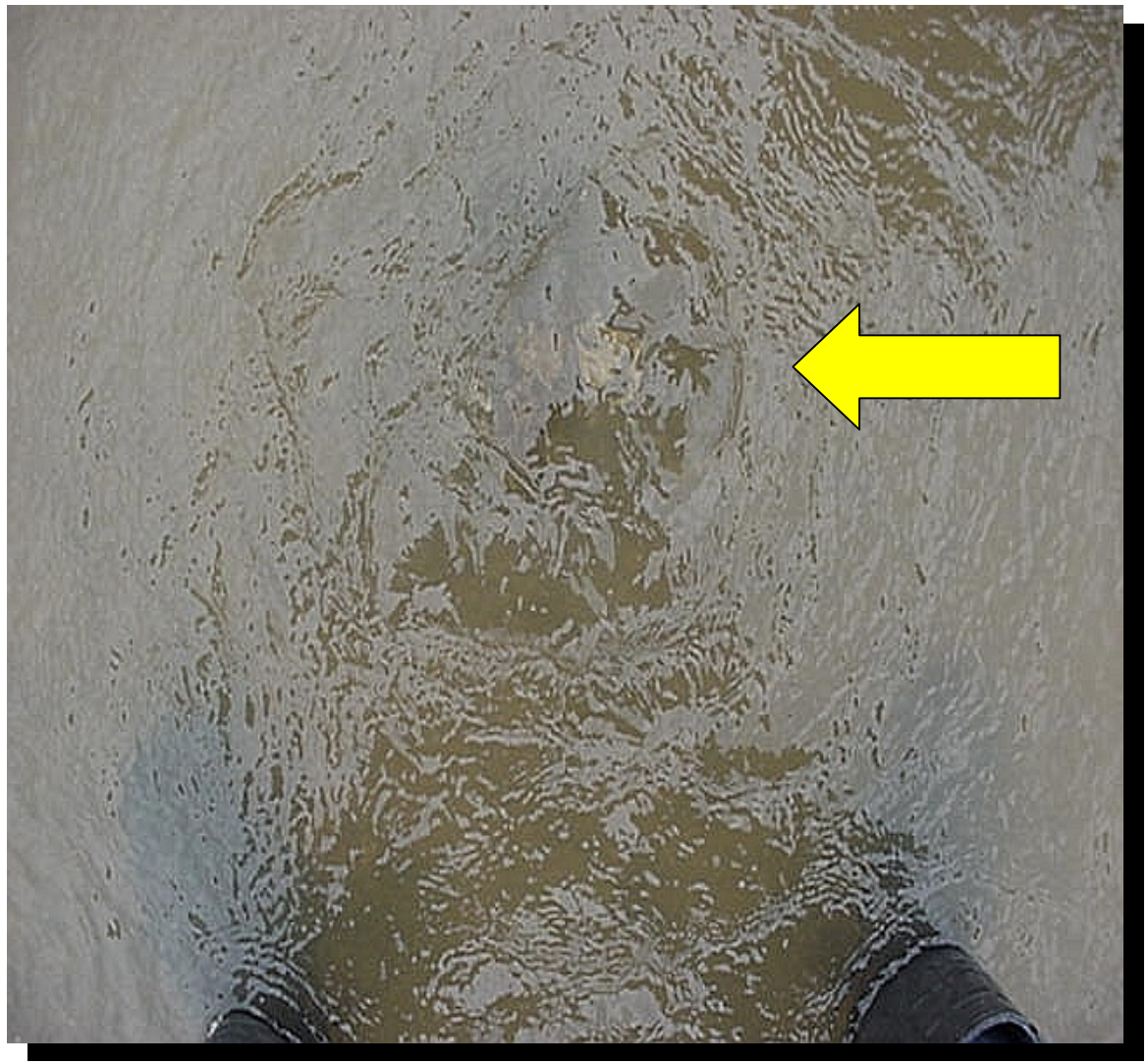
SPRINGS OBVIOUS ON THERMOGRAPHY MAY NOT BE OBVIOUS IN THE FIELD



- Summary of N Alabama site results
  - 45 springs found in the field
  - Total known groundwater discharge
    - Pre-thermography ~ 6 cfs
    - Post-thermography ~ 24 cfs
    - Largest new spring (10 cfs)
  - New springs used to unravel ground water plumbing

Groundwater Upwelling

This boil was identified with the nighttime thermal infrared survey and was measured with a flow meter at 4 cfs. The same constitutes that were in the landfill near the base 2 miles away were found here.



Groundwater Spring & Seep Detection

Identifying where groundwater is coming into surface water is a major hurdle in assessing the health of a watershed. Thermal imagery, when used properly can be a valuable phase I step in determining watershed hydrology.

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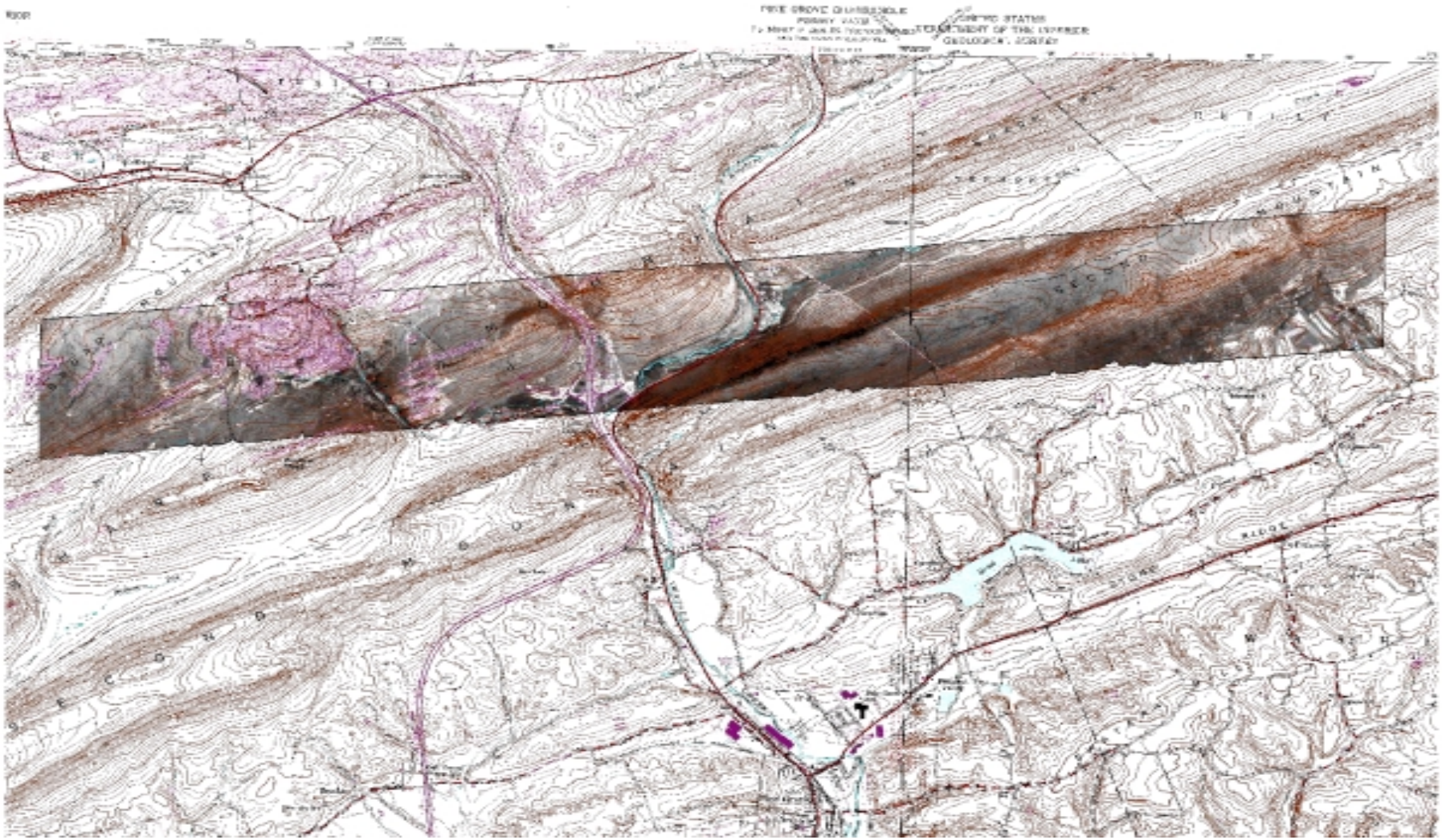
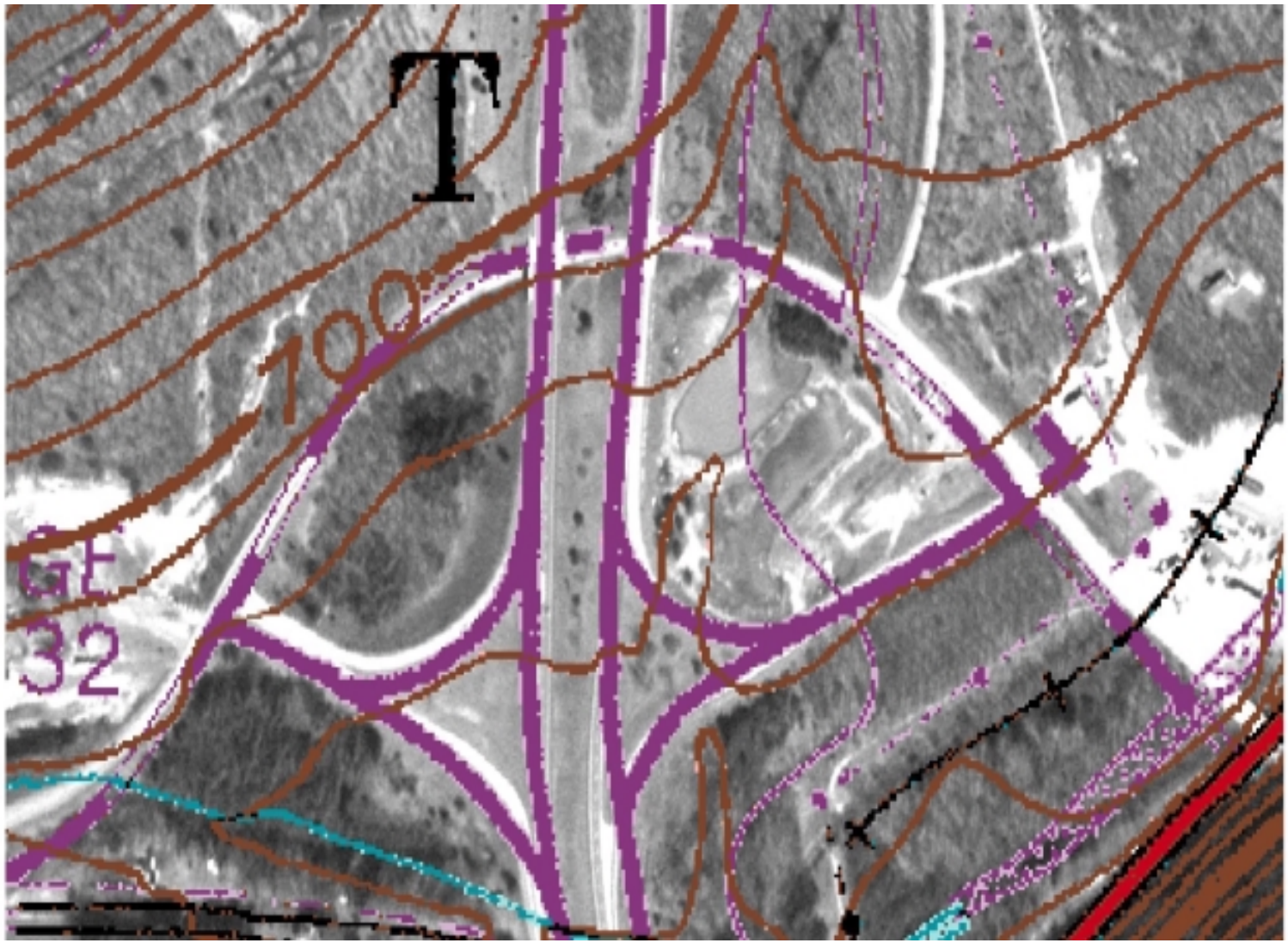
Ground Truthing

Ground truthing is an essential step in order to conclusively understand what the thermal anomalies are in the imagery as they relate to whats happening on the ground. Measuring flow, collecting water samples and recording exact location were all important aspects of the project.

Georeferencing Scanner Data



Georeferencing Scanner Data



Geometric Correction

Corrected Data

Raw, Uncorrected data